THE USE OF RECLAIMED WATER FOR ENHANCING AND CREATING WETLAND AND WILDLIFE HABITAT: EFFICACY AND EFFECTS

Hudeman Slough Mitigation and Enhancement Wetlands Case Study

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EXECUTIVE SUMMARY

The proliferation of wetland enhancement and creation projects during recent decades has led to some unusual solutions for creating wetland hydrology, particularly in regions where water is scarce or regulatory constraints prohibit tapping into rivers or adjacent bays and estuaries. One solution involves using treated or "reclaimed" wastewater to create or enhance wetland systems. Typically, these projects involve flooding wetlands with reclaimed water to create wildlife habitat, particularly for overwintering or migrating waterbirds.

Use of reclaimed water for wetland enhancement or restoration has raised concerns about the potential impact of reclaimed water on existing biota. While the use of constructed wetlands for treating wastewater is widely accepted, the potential for using reclaimed wastewater to create or enhance wetlands is often greeted with skepticism from many regulators and biologists. Some concerns focus on discharges of low salinity water into areas or during seasons where high salinities are typically present, but for most the crux is the potential for anthropogenic eutrophication and the ecological fate of contaminants such as metals, pesticides, and polychlorinated biphenyls (PCBs), particularly in estuaries.

The California Department of Fish and Game (CDFG) is evaluating the use of reclaimed water for restoration of the 10,000-acre former Leslie-Cargill salt pond complex in San Pablo Bay (Napa-Sonoma Marsh Project). Preliminary analyses indicated that some of the more saline ponds would require large volumes of freshwater to dilute outflow salinity levels before discharge to San Pablo Bay or for habitat enhancement. Use of river water for dilution was constrained by the need for fish screens to ensure that the project did not entrain threatened or endangered fish species, and other sources of water were cost-prohibitive. CDFG was already working with the Sonoma Valley County Sanitation District (SVCSD) in managing use of reclaimed water for SVCSD's Hudeman Slough Mitigation and Enhancement Wetlands (Hudeman Slough Enhancement Wetlands) Project. In 1990, SVCSD began to enhance and create wetlands along the upland edge of San Pablo Bay. The project involved enhancement of diked subsaline seasonal wetlands, as well as muted tidal marsh, and creation of seasonal wetland and perennial freshwater marsh ponds using secondary-level treated wastewater.

Since project completion, the Hudeman Slough Enhancement Wetlands have attracted thousands of overwintering and migrating waterbirds. However, serious concerns about the effects of this approach on the wetland ecosystems being restored or created still exist. Little detailed information about these types of projects exists, particularly projects oriented exclusively at enhancing wildlife habitat rather than performing wastewater treatment. In 1999, SVCSD, through its agent, the Sonoma County Water Agency, launched a study to evaluate the ecological health and status of the project.

A two-year monitoring study was designed to evaluate the effects of reclaimed water use within the Hudeman Slough Enhancement Wetlands, using other hydrologically managed and unmanaged wetlands as "reference" areas. Between 1999 and 2001, we compared water and sediment nutrients, sediment contaminant levels, benthic invertebrate and zooplankton densities, and avian use between the Hudeman Slough Enhancement Wetlands and nearby reference areas.

The Study Area is located in the northern portion of San Pablo Bay in north San Francisco Bay, California. The Study Area comprised both managed and unmanaged hydrological regimes. Hydrologically managed monitoring units included: Reclaimed Water, Reclaimed Water + Muted Tidal, Muted Tidal, Passive Hydrologic Management, and Upland Pond Managed with Groundwater. Hydrologically unmanaged monitoring units consisted of Diked Marsh, Seasonal Ponds, and Undiked Marsh.

Reclaimed water areas were ecologically comparable to other hydrologically managed or unmanaged areas. Dissolved oxygen and other water quality parameters did not suggest that areas managed with reclaimed water were more eutrophic than other hydrologically managed or unmanaged monitoring units. However, dissolved phosphates were only detected in water quality samples collected in Reclaimed Water monitoring units. While the units were actively flooded with reclaimed water, dissolved phosphates were at concentrations well below the average concentration of the treatment plant effluent, suggesting that the units may be acting as a sink. Flocculation of dissolved phosphates and incorporation into the sediment may be favored, at least slightly, over immediate uptake by biota by the fact that waters in areas receiving the non-saline reclaimed water are slightly saline (1-5 ppt), thereby creating a small-scale "entrapment zone." Further evidence for this comes from the fact that dissolved phosphates were detected even during a season when the units were not actively flooded with reclaimed water. Nocturnal anoxic events or strong stratification within the water column may enable solubilized phosphate within the sediment to release periodically into overlying waters. However, this scenario was contradicted somewhat by sediment phosphorous data. While mean sediment phosphorous concentrations were comparatively high in the Reclaimed Water + Muted Tidal monitoring unit, phosphorous levels in the Reclaimed Water monitoring unit remained moderate and similar to those in the Muted Tidal and Undiked Marsh monitoring units, suggesting that either the reclamation storage reservoirs or the monitoring units may be acting as a sink. Furthermore, phosphorous concentrations in the Reclaimed Water and most of the other monitoring units showed almost no variation between seasons, thereby discounting the possibility that concentrations could increase substantially after flooding with reclaimed water and then drop once phosphorous within sediments was solubilized and released to surface waters. Concentrations of sediment contaminants and potentially problematic macronutrients such as nitrogen were comparatively low in units receiving reclaimed water relative to other monitoring units. Areas managed with muted tidal flushing had the highest or second highest mean concentrations of total ammonia and nitrates in water and organic matter, organic and inorganic nitrogen (TKN), and ammonium in sediments.

High zooplankton densities and low densities of benthic invertebrates suggested that zooplankton, epifauna, and macrophytes were the major prey items available among all study areas. Managed wetlands typically exhibited the highest zooplankton densities. Low infaunal densities in all areas, including undiked marshes, were likely due to anoxic conditions in the predominantly clay substrates.

In Open Water habitats, waterbird species richness, diversity, and densities in the Reclaimed Water units were comparable to or exceeded those found in the Seasonal Pond units (which do not receive reclaimed water). No significant differences in waterbird species richness, diversity,

and densities were detected between Reclaimed Water and Muted Tidal flooded wetland habitats during the study.

Acidification episodes observed during the study emphasized the importance of water management. Some Muted Tidal units became hydrologically isolated during the study and underwent acidification episodes, with water pH declining to 3-4. The acidification episodes corresponded to periods when the units were either hydrologically disconnected, were only weakly connected, or had just been "reconnected" after a prolonged period of desiccation. Low zooplankton densities and minimal waterbird use accompanied these episodes, which were not observed within Reclaimed Water units. Once flushing with tidal flows was reintroduced, pHs approached neutral.

In designing or managing wetland enhancement, restoration, or creation projects, consideration and management of the hydrologic regime appears to be as important, if not more important, than water source. Use of reclaimed water did not produce levels of eutrophication or contaminant loading in sediments within enhanced or created wetlands that were higher than those managed with other water sources, such as tidal flushing or groundwater. In fact, in some cases, concentrations of pollutants such as sediment contaminants were actually much lower. As for water quality-related problems that have been experienced at other reclaimed water wetland projects, most did not currently appear to be issues at the Hudeman Slough Enhancement Wetlands. The problems that were observed (a one-time spike in unionized ammonia, episodic anoxic or hypoxic events resulting in fish kills, and possible sediment loading and subsequent remobilization of phosphates) could perhaps be eliminated or minimized by careful hydrologic management.

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